

NASA TECH BRIEF



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Measurement of Surface Roughness Slope

The problem:

The thermal contact conductance between metallic surfaces (joint interfaces) depends on the surface texture. If the surface texture consists only of roughness, then the contact conductance depends on the root mean square (rms) roughness height, σ , and the average of the absolute value of the roughness slope, $\tan \theta$. The roughness height and slope are related by the expression:

$$\frac{\sigma_{hc}}{K_s \tan \theta} = 0.9 \left(\frac{P}{H} \right)^{16/17}$$

where hc is the vacuum thermal conductance, P is the applied axial load, H is the microhardness number, and K_s is the thermal conductivity. Surface texture analyzers can readily measure the rms roughness height. However, $\tan \theta$ has to be determined either by digital and analog computers or by tedious graphic techniques.

The solution:

Employ a circuit which uses the output signal from a surface texture analyzer profile-amplifier to calculate

$$\tan \theta = \frac{1}{L} \int_0^L \left| \frac{dy}{dx} \right| dx$$

where L is the specimen length, and y is the profile height signal as a function of distance x . The calculations provide an accurate, instantaneous value of $\tan \theta$. The instrument is inexpensive and can be applied to any commercial surface texture analyzer.

How it's done:

The instrument, consisting of an isolator, a differentiator, an absolute value circuit, and an integrator, has been adapted to a commercial surface analyzer. Values of $\tan \theta$ from zero to 0.30 are indicated by a meter or a strip chart recorder. Thus, $\tan \theta$

is measured continuously during a profile trace. The input frequency bandwidth is one to five Hertz and the input voltage level can vary from one to four volts, peak-to-peak. The output voltage is linear to within $\pm 1\%$ of full scale and has a range of 0.1 to 3.0 volts at a probe speed of 0.01 inch/sec. Consequently, $\tan \theta$ values are obtained for a wide range of machined, bead-blasted, or electro-etched surface textures. Excellent agreement has been obtained between the instrument measurements and computer results of the $\tan \theta$ for general surfaces, as well as for a special triangular wave surface of known included angle.

Note:

No further documentation is available. Specific questions, however, may be directed to:

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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

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